

# Laser System for SLR with a Diode-Pumped Microlaser used as a Master Oscillator

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## Abstract

A Master Oscillator - Power Amplifier - Frequency Doubler laser system has been developed for use in SLR-stations, particularly compact ones. The master oscillator is a diode-pumped microchip-laser providing short output pulses.

The pulse energy at the system output is 40 mJ at  $\lambda = 532$  nm, with the pulsewidth  $\sim 200$  ps and pulse repetition frequency 10 Hz.

## Introduction

The basic part of any laser system for SLR is the master oscillator, defining the most important parameters - pulsewidth, beam axis stability, etc.

Below a description is presented of a hybrid laser transmitter consisting of a diode-pumped microchip-laser as a master oscillator, a flashlamp-pumped laser amplifier, and a frequency doubling unit.

The output energy of this system is  $\sim 40$  mJ at  $\lambda = 532$  nm, the pulsewidth is  $\sim 200$  ps, the pulse repetition frequency is 10 Hz. The system operates normally within a temperature range  $10^{\circ}\text{C} \dots 35^{\circ}\text{C}$  during 8 hours of uninterrupted operation.

## 1. Laser system block diagram

The laser system block diagram is shown in Figure 1.

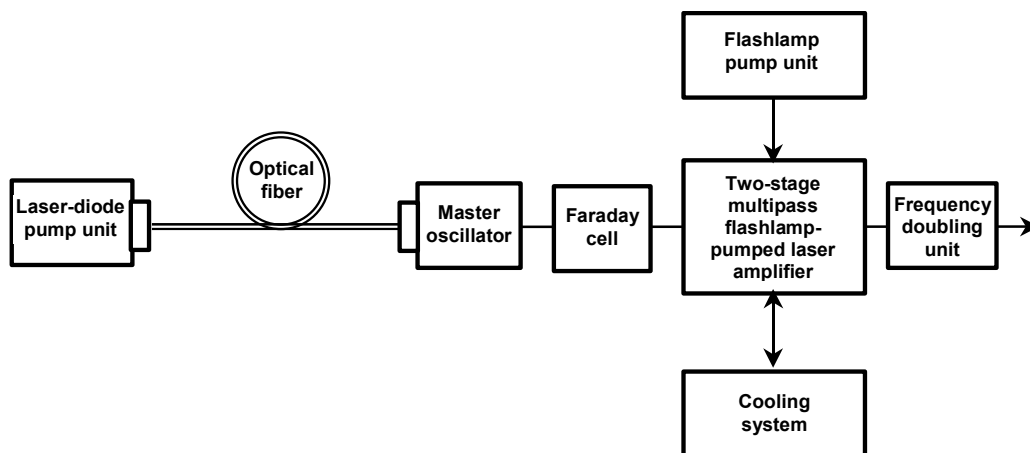
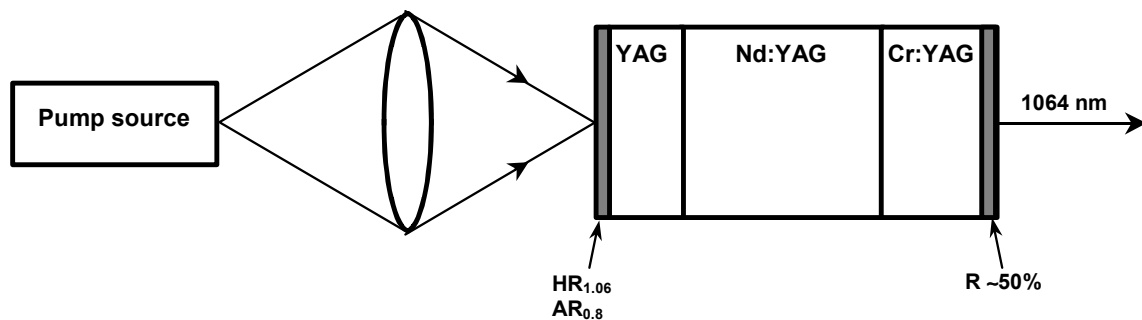


Fig. 1. Laser system block diagram

The master oscillator is a diode-pumped microchip-laser. The pumping radiation for the microchip-laser is delivered from a laser-diode pump unit via an optical fiber. The output radiation of the microchip-laser is amplified by a two-stage multipass flashlamp-pumped laser power amplifier. The Faraday cell serves as an optical isolator between the master oscillator and the laser power amplifier. The power amplifier is provided with a cooling system. The master oscillator has a natural (convective) cooling.

## 2. Master oscillator

The master oscillator optical layout is shown in Figure 2.



**Fig. 2. Master oscillator optical layout**

The active element (microchip) consists of three aluminium-itrrium garnet layers connected in a single monolithic unit (length 7 mm, diameter 5 mm) by diffusion welding. The first layer is a pure  $Y_3Al_5O_{12}$ ; the second layer is Nd-doped, with Nd concentration about 1 at. percent; the third layer is  $Cr^{4+}$ :YAG with a concentration of chromium atoms  $\sim 10^{18} \text{ cm}^{-3}$ . Nd:YAG is the active medium, Cr:YAG serves as a passive Q-switch.

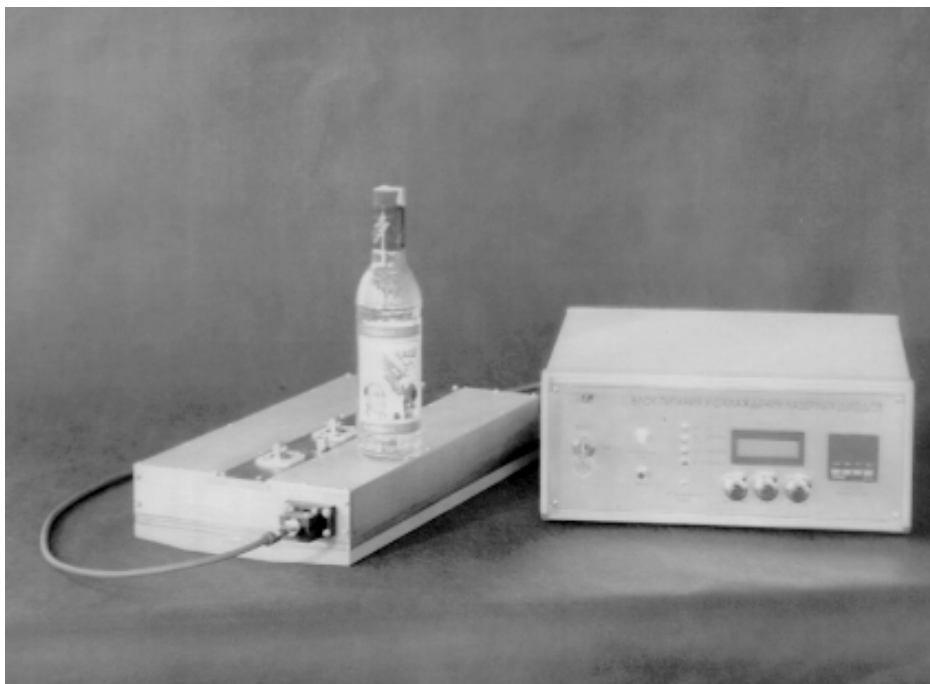
The crystal unit flat ends are made parallel to each other within 2 arcsec and have dielectric mirror coatings. The flat looking towards the laser-diode pump source (LD) has a coating with a  $\geq 99\%$  reflectivity at  $\lambda=1064 \text{ nm}$  but high transparency ( $T>95\%$ ) for the pumping radiation ( $\lambda=808 \text{ nm}$ ). The output mirror has a reflectivity  $R\sim 50\%$ .

The GaAlAs laser diode bars of the pump unit provide an output power of 30 W. The pumping radiation is delivered to the solid-state laser via an optical fiber (diameter 0.6 mm, length 2 m,  $NA=0.22$ ) and focused by a lens in a spot 0.3 mm in diameter at the microchip flat end. The pumping pulsewidth is 0.25 ms, and the pulse repetition frequency may be varied within a 5 to 100 Hz range.

The pumping pulse energy depends on the LD current and may be varied within a 4 to 8 mJ range.

At reaching the threshold level, a high-power output pulse is generated at the pumping pulse tail. With the presented parameters of pumping, the laser pulse energy is 0.25 to 0.35 mJ, and the pulsewidth is 260 to 280 ps (the corresponding power is  $\sim 1.3$  MW, the power density is  $\sim 2$  GW/cm<sup>2</sup>). The beam diameter is 0.3 mm, the beam divergence is less than 2 diffraction limits. The power density distribution within the beam cross-section is gaussian (TEM<sub>00</sub> mode). Because of the small resonator length, a single longitudinal mode takes part in the oscillation (i.e., the oscillation is a single-frequency one). The laser radiation has a linear polarization.

The microlaser appearance with the power supply is shown in Figure 3.



Pulse energy	40 mJ
Wavelength	532 nm
Pulse width	200 psec
Repetition rate	10 Hz
Operation temperature range	15°C...30°C

**Fig. 3. The microlaser appearance with the power supply unit**